free layer. For example, the free layer may have a structure of 0.3 nm Co/2 nm NiFe/0.5 nm Co, or 0.5 nm CoFe/2 nm NiFe/0.5 nm CoFe.

In place of the ultra-thin, laminated films of magnetic layers, an alloy free layer of NiFeCo may also be employed.

Ultra-thin free layers to which the invention is directed could hardly realize low magnetostriction. One reason for the difficulty is that the magnetostriction of NiFe becomes larger in positive when the thickness of the NiFe layer is smaller. In order to overcome the problem, the NiFe composition could be $Ni_{80}Fe_{20}$ (at.%) in an ordinary free layer of 8 nm NiFe/1 nm CoFe. However, in the free layer of the invention having a magnetic thickness of not larger than 4.5 nanometer Tesla, it is desirable that the NiFe composition is an Ni-rich one over $Ni_{80}Fe_{20}$. Concretely, for the NiFe film having a thickness of 4 nanometers or so, desired is an Ni-rich composition over $Ni_{81}Fe_{19}$ (at.%); and for the NiFe film having a thickness of 3 nanometers or so, desired is an Ni-rich composition over $Ni_{81.5}Fe_{18.5}$ (at.%). It is desirable that the uppermost limit of the Ni content of NiFe is not over $Ni_{90}Fe_{10}$ (at.%).

As mentioned above, the subbing Cu layer is to attain two major objects. One is to reduce the current magnetic field Hcu for good bias point control even in ultra-thin free layers; and the other is to exhibit the MR spin filter effect without

lowering the MR ratio even in ultra-thin free layers.

From the viewpoint of bias point control, the factors y and x in the film (7-1) are determined in mutuality but not independently. For example, when y is smaller, then Hpin is also smaller. In this case, the current magnetic field Hcu to cancel Hpin is preferably also smaller, and the value of x is preferably larger for the best results.

Concretely, one example of film thickness designing where the nonmagnetic high-conductivity layer is of Cu is as follows: When the pinned layer has 2 nanometer Tesla, the Cu layer thickness is from 0.5 to 1.5 nm; when the pinned layer has 1.5 nanometer Tesla, the Cu layer thickness is from 1 to 2 nm; when the pinned layer has 1 nanometer Tesla, the Cu layer thickness is from 1.5 to 2.5 nm; when the pinned layer has 0.5 nanometer Tesla, the Cu layer thickness is from 2 to 3 nm; and when the pinned layer has 0 nanometer Tesla, the Cu layer thickness is from 2.5 to 3.5 nm.

Where the pinned layer is of Co or CoFe, its thickness shall be t = (Msxt)pin/1.8T [nanometer]; and where the pinned layer is of NiFe, its thickness shall be t = (Msxt)pin/1T [nanometer].

In the example 1, thickness of the pinned layer disposed to the spacer layer is larger than that of the another pinned layer, however it is possible that the pinned layer disposed on the spacer layer is smaller that that of the another pinned

layer. In that case, the direction of the current flow is opposite to the before case. In another wards, the direction of the Hpin and the Hcu should be always opposite to each other.

In place of Cu, the spacer layer may be of any other element of Au or Ag, or may be of an alloy comprising those elements. However, Cu is the best. For realizing high MR and for reducing as much as possible the thickness of the shunt layer that is on the free layer at the side opposite to the side of the underlayer to thereby reduce the current magnetic field, it is desirable that the spacer thickness is as small as possible. However, if the spacer is too small, the ferromagnetic coupling between the pinned layer and the free layer will increase to enlarge Hin. Preferably, therefore, the spacer thickness falls between 1.5 nanometers and 2.5 nanometers, more preferably between 1.8 nanometers and 2.3 nanometers.

The subbing high-conductivity layer to fill the significant roles of the spin filter effect and the current magnetic field reduction is herein a single layer of Cu. The layer may also be of a laminate film. In the top-type spin valve film, the layer acts also as an fcc seed layer. Therefore, the material of the underlayer is preferably an fcc or hcp metal material. Concretely, the layer may be an alloy layer of metals of Au, Ag, Al, Zr, Ru, Rh, Re, Ir, Pt, etc.; or it may be of a laminate layer of those metals. For only the MR spin